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EFFECT OF NITROGEN, PHOSPHOR AND POTASSIUM FERTILIZATION ON YIELD OF FLAX AND QUALITY UNDER SANDY SOILS.

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ABSTRACT

Genotypes selection and optimizing mineral nitrogen, phosphorus and potassium fertilization are important factors that influence flax growth, yield and quality. Two field experiments were conducted at the Experimental Research Station in Esmailia, Field Crops Research Institute, Agricultural Research Center, Egypt during the growing seasons of 2012/2013 and 2013/2014 seasons to study the effect of mineral nitrogen, phosphorus and potassium fertilization on yield and quality of some flax genotypes under sandy soils conditions. The experiments were carried out in a split-plot design with three replicates. The main-plots were assigned to flax genotypes (Giza 10, Sakha 2 and strain 22). The sub-plots were allocated to mineral fertilization treatments (fertilizing with mineral N, P, K, NPK and without mineral fertilization).

The results indicated that significant differences among the three studied flax genotypes *i.e.* Giza 10, Sakha 2 and strain 22 were detected in all studied characters, except number of seeds/capsule in both seasons.

Fertilizing flax plants with 75 kg N + 23.25 kg P_2O_5 + 24.0 K_2O/fed significantly increased all studied characters and produced the highest values as compared with other studied mineral fertilization treatments in both seasons. Control treatment (without mineral fertilization) gave the lowest values of all studied characters.

On the basis of the results obtained, maximum straw and seed yields and its components of flax could be achieved through fertilizing Strain 22 or Sakha 2 genotypes with 75 kg N + 23.25 kg P_2O_5 + 24.0% K_2O/fed. However, maximum fiber flax yield resulted from fertilizing Giza 10 cultivar with 75 kg N + 23.25 kg P_2O_5 + 24.0 K_2O/fed under sandy soils conditions in Esmailia Governorate.

Keywords: Flax, Genotypess, Cultivars, Varieties, nitrogen, phosphorus, potassium, NPK, Yields, fiber quality.

INTRODUCTION

Flax (*Linum usitatissimum* L.) production dates back to ancient history. Flax is a dual purpose crop that is grown for fiber and oil production. The gap between the production and local requirements increased because it is difficult to increase flax area due to great competition from other major winter crops. The gap could be minimized partly by increasing flax yield per unit area through sowing high yielding genotypes and optimizing the agricultural practices for growing flax among them mineral nitrogen, phosphorus and potassium fertilization.

Sowing the suitable genotypes is important factor to enhance growth, yields and its components and quality parameters of flax. In this connections, by many investigators indicating that there are significant differences due to flax genotypes in growth, yields, yield components and quality traits due to the differences in genetic structure and their interaction with environmental conditions prevailing during growing season (Rahimi and Nourmohamadi, 2010 and Abd El-Mohsen *et al.,* 2013). Al-Doori (2012) and Bakry *et al.* (2012)showed that flax crop genotypes significantly differed for all studied yield and its component. The highest number of capsules/plant, 1000-seed weight, seed and oil yield/ha were produced from strain genotype. Wadan (2013) reported that the two tested cultivars (Sakha 1 and Sakha 2) exhibited significant differences for almost traits. Gallardo et al. (2014) indicated that significant differences among flax Genotypes were found for all studied characters. The best seed yields were observed in Prointa Lucero and Carap´e INTA varieties. Bakry et al. (2015) reported that Sakha-2 variety significantly surpassed Amon variety in plant height, technical length, seed yield/plant, straw yield/plant, 1000 seed weight, seed yield/fed, straw yield/fed, fiber %, fiber yield/fed and oil yield/fed. While, Amon variety surpassed Sakha-2 in fruiting zone length, number of capsules/plant and oil %.

Nitrogen is often the most important plant nutrients, which influences the amount of protein, protoplasm and chlorophyll formed, consequently increases cell size, leaf area and photosynthetic activity. The response of flax to nitrogen has been well established, as has the sensitivity of crop emergence and seed yield to seed-placed nitrogen (Lafond et al., 2003). Many researchers have decided that using nitrogen fertilizer in suitable needed level could improve yields and its components as well as quality of flax, including Zimmermann et al. (2006), Lafond et al. (2008), Dordas (2010), El-Nagdy et al. (2010), Rahimi et al. (2011), Homayouni et al. (2013) and Soethe et al. (2013).

Phosphorus fertilizer is second only to nitrogen fertilizer in importance as an essential crop nutrient. Phosphorus is a structural component of nucleic acids and plays a crucial role in reproductive growth (Marschner, 1995). It is an essential nutrient for crop production due to its improvement of physiological functions (Jiao *et al.,* 2013). In this respect, Khan *et al.* (2000) reported that mean performances of flax differed for seed and straw yields with the application of phosphorus fertilizers. Ali *et al.* (2002) found that flax had a significant response to phosphorus application.Lafond et al. (2003) cleared that flax response to phosphorus fertilizer additions had highly variable, supporting the importance of maintaining medium to high soil P-levels to optimize flax yields. El-Nagdy et al. (2010) indicated that increasing level of the used mineral phosphorus fertilizer induced significant increases in all investigated morphological and yield characters, except number of seeds/capsule and seed oil percentage. Emam and Dewdar (2015) showed that phosphorus treatments were significantly affected straw, seed and oil yields.

Potassium (K) is participate in many important functions in plants *i.e.* photosynthesis, translocation of photosynthates, protein synthesis, control of ionic balance, regulation of plant stomata and water use (Marschner, 1995 and Reddya *et al*., 2004), enzyme activation and osmoregulation (Mengel, 2007). Also, potassium enhances the ability of plants to resist stress such as diseases, pests, cold and drought. Potassium performs these roles in all crops and flax, therefore it is important plant nutrient to sustain high productivity and quality, in equilibrium with other essential plant nutrients, so it is important to ensure adequate potassium for flax crop. Bakry et al. (2015) found that increasing potassium soil application up to the rate of 100 kg/fed gave the highest values of plant height, technical length, fruiting zone length, number of capsules/plant, seed yield/plant, straw yield/plant, 1000 seed weight, seed yield/fed, straw yield/fed, fiber %, fiber yield/fed, oil % and oil yield/fed.

NPK fertilization is among the vital factors affecting growth, yield and quality of flax. Thus, application the suitable level of NPK is one of the favorable factors for increasing flax productivity and quality. In this respect, Sudakov et al. (1993) indicated that application of 20 kg N + 30 kg P_2O_5 + 90 kg K_2O/ha was adequate for a favorable annual harvest of 17 - 21 t/ha of flax of CVS. K-6 and Mogilevsk-1. Dubey (1994) found that the highest seed yields and net returns of flax cv. JLS-23 came from application of 60 kg N and 30 kg P_2O_5/ha. Chaubey and Dwivedi (1995) showed that significant responses were recorded with up to 80 kg N, 50 kg P_2O_5 and 30 kg S/ha. Lafond et al. (2003) showed that combined NPK fertilizers placement as a side band when seeding flax was found to be a viable option. Leilah et al. (2003) revealed that NPK fertilizers treatments caused significant effects on all studied characters. Adding 60 kg N + 15 kg P_2O_5 + 24 kg K_2O/fed most of the studied characters.

The purpose of this investigation was to study the effect of mineral nitrogen, phosphorus and potassium fertilization on yield and quality of some flax genotypes under sandy soils conditions in Esmailia Governorate.

MATERIALS AND METHODS

Two field experiments were conducted at Esmailia Agricultural Stationin, Agricultural Research Center, during the growing seasons of 2012/2013 and 2013/2014 seasons to study the effect of mineral nitrogen, phosphorus and potassium fertilization on yield and quality of some flax genotypes under sandy soils conditions.

The experiments were carried out in a split-plot design with three replicates. The main-plots were assigned to three flax genotypes *i.e.* Giza 10, Sakha 2 and strain 22. The studied Egyptian flax genotypes were obtained from Fiber Research Section, FCRI, ARC, Giza, Egypt.

The sub-plots were allocated to five mineral fertilization treatments as follows:

1. Fertilizing with mineral nitrogen (N) only.
2. Fertilizing with mineral phosphorus (P) only.
3. Fertilizing with mineral potassium (K) only.
4. Fertilizing with mineral nitrogen, phosphorus and potassium (NPK).
5. Without mineral fertilization.

The mineral nitrogen fertilizer in the form of ammonium nitrate (33.5 % N) at the rate of 75 kg N/fed. was applied in four equal doses at sowing, 30, 45 and 60 days from sowing, recpectively. The mineral phosphorus fertilizer in the form of calcium superphosphate (15.5% P_2O_5) at the rate of 150 kg/fed. and mineral potassium fertilizer in the form of potassium sulphate (48.0% K_2O) at the rate of 50 kg/fed. were added before sowing and during seed bed preparation (after ploughing and before division).

Each experimental unit area was 2 × 3 m occupying an area of 6.0 m^2 *i.e.* 1/700 feddan. The preceding summer crop was peanut (*Arachis hypogaea* L.) and kenaf (*Hibiscus cannabinus* L.) in the first and second seasons, respectively. The soil of experimental site was characterized as a sandy soil as shown in Table 1, which cleared some physical and chemical properties.

Table 1: Some physical and chemical properties of the experimental site during 2012/2013 and 2013/2014 seasons.

	Physical characteristics					
Properties / Seasons	Coarse sand (%)	Fine sand (%)	Silt (%)	Clay (%)	$CaCO_3$ (%)	Soil texture
2012/2013	81.56	7.57	4.21	6.66	2.62	Sandy
2013/2014	81.12	7.35	4.59	6.94	2.68	Sandy

	Chemical characteristics											
Properties / Seasons	pH	EC dSm^{-1}	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	HCO_3	Cl^{-}	SO_4^{--}	N	P	K
2012/2013	7.70	1.26	2.41	1.18	8.37	0.64	5.82	3.87	2.91	21.7	7.54	51.0
2013/2014	7.74	1.30	2.49	1.12	8.71	0.68	5.87	3.94	3.19	21.3	7.06	47.0

Fax genotypes were sown on 10^{th} and 7^{th} November in the first and second seasons, respectively by using broadcasting method at the recommended rate of each genotype. The sprinkler irrigation system was used for irrigation. The common agricultural practices for growing flax according to the recommendations of Ministry of Agriculture were followed, except the factors under study.

At full maturity, ten guarded plants were taken at random from each sub-plot to be used in recording the yield components characters of flax. Flax yield for straw and seed per feddan were recorded on the whole sub-plot area basis. Ten plants were retting in tubes to estimate fiber yield and quality.

Studied Characters:

A- Straw yield and its components:

1-Technical length (cm). The length of main stem in cm from cotyledonary node to the lowest branching zone.

2-Stem diameter (mm). It was measured at the middle of technical length.

3-Straw yield/plant (g). As the total weight in grams of the air dried straw per plant after removing the capsules.

4-Straw yield/fed (ton). It was estimated from the rest area of each plot.

B-Seed yield and its components:

1- Fruiting zone length (cm).

2- Number of capsules/plant.

3- Number of seeds/capsule.

4- Number of seeds/plant.

5- Seed yield/plant (g).

6- Seed yield/feddan (kg).

B- Fiber yield and its quality:

1- Fiber length (cm). Ten fiber ribbons from every treatment were measured in cm average fiber length of these records was calculated.

2- Fiber yield/plant (g).

3- Fiber strength (R.K.M.).

4- Fiber fineness (N.m.). It was determined using Radwan and Momtaz (1966) method according to the following equation:

$$N = N \times L/G$$

Where:

N = Number of fibers (20 Fibers each 10 cm long).
L = Length of fibers in cm
G = Weight of fibers in mg

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the split– plot design as published by Gomez and Gomez (1984) by using MSTAT statistical package (MSTAT-C with MGRAPH version 2.10, Crop and Soil Sciences Department, Michigan State University, USA). Least significant difference (LSD) method was used to test the differences between treatment means at 5 % level of probability as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

1. Genotypes performance:

Significant differences among the three studied flax genotypes *i.e.* Giza 10, Sakha 2 and strain 22 were detected in technical length, stem diameter, straw yield/plant, straw yield/fed, fruiting zone length, number of capsules/plant, number of seeds/plant, seed yield/plant and seed yield/fed, fiber length, fiber yield plant, fiber strength and fiber fineness during the two growing seasons as shown from data in Tables 2, 3 and 4. Whereas, the three studied flax genotypes did not differed among them in number of seeds/capsule in both season (Table 3).

Table 2: Averages of technical length, stem diameter, straw yield/plant and straw yield/fed as affected by mineral nitrogen, phosphorus and potassium (NPK) fertilization treatments of some flax genotypes and their interaction during 2012/2013 and 2013/2014 seasons.

Characters	Technical length (cm)		Stem diameter (mm)		Straw yield (g/plant)		Straw yield (t/fed)	
Treatments Seasons	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014
A- Genotypes:								
Giza 10	73.1	65.9	1.60	1.54	0.732	0.757	2.059	2.284
Sakha 2	71.4	61.1	2.28	2.41	0.715	0.720	2.804	3.041
Strain 22	62.7	56.5	1.55	1.30	0.517	0.558	2.611	2.637
LSD at 5 %	0.8	1.1	0.11	0.21	0.020	0.023	0.142	0.164
B- Mineral fertilization treatments:								
Nitrogen (N) only	71.1	64.8	1.87	1.78	0.735	0.774	2.656	2.979
Phosphorus (P) only	68.7	59.8	1.69	1.66	0.626	0.645	2.605	2.686
Potassium (K) only	67.1	58.9	1.66	1.60	0.634	0.632	2.117	2.206
Combined NPK	74.7	68.7	2.01	2.17	0.817	0.817	3.106	3.304
Without	63.8	53.6	1.82	1.54	0.462	0.525	1.972	2.095
LSD at 5 %	0.7	1.3	0.13	0.23	0.022	0.034	0.176	0.192
C- Interaction: A×B (F. test)	NS	NS	NS	NS	*	*	*	*

Table 3: Averages of fruiting zone length, number of capsules/plant, number of seeds/capsule, number of seeds/plant, seed yield/plant and seed yield/fed as affected by mineral nitrogen, phosphorus and potassium (NPK) fertilization treatments of some flax genotypes and their interaction during 2012/2013 and 2013/2014 seasons.

Characters / Treatments Seasons	Fruiting zone length (cm)		Number of capsules /plant		Number of seeds/ capsule		Number of seeds/plant		Seed yield (g/plant)		Seed yield (kg/fed)	
	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014
A- Genotypes:												
Giza 10	9.43	9.05	5.26	5.90	6.56	6.58	34.21	40.87	0.260	0.330	308.4	318.4
Sakha 2	10.84	10.23	6.73	8.58	6.58	6.90	60.49	61.59	0.349	0.497	375.3	391.0
Strain 22	10.90	10.65	8.85	8.94	6.59	6.66	42.69	61.24	0.316	0.326	426.2	432.0
LSD at 5%	0.24	0.34	0.56	0.38	NS	NS	4.86	5.06	0.028	0.030	10.5	14.4
B- Mineral fertilization treatments:												
Nitrogen (N) only	11.76	11.35	7.52	9.38	6.80	7.08	51.68	66.60	0.362	0.480	390.0	389.3
Phosphorus (P) only	10.40	9.67	7.21	7.63	6.46	6.62	46.51	50.50	0.302	0.341	370.2	388.7
Potassium (K) only	8.91	8.68	6.24	6.34	5.98	6.30	36.31	42.43	0.238	0.317	331.9	364.2
Combined NPK	13.43	13.11	9.18	10.68	7.83	7.96	68.70	85.25	0.503	0.633	448.1	459.9
Without	7.45	7.09	4.58	5.00	5.81	5.60	25.78	28.04	0.135	0.151	309.7	300.2
LSD at 5%	0.20	0.39	0.39	0.47	0.31	0.41	5.25	9.98	0.024	0.040	16.8	19.9
C- Interaction: A×B (F. test)	*	*	NS	NS	NS	NS	*	*	*	NS	*	*

Giza 10 cultivar surpassed other studied genotypes (Sakha 2 and Strain 22) in technical length, straw yield/plant, fiber length, fiber yield plant, fiber strength and fiber fineness in the two growing seasons. However, Sakha 2 cultivate superior Giza 10 and Strain 22 in stem diameter, straw yield, number of seeds/capsule, number of seeds/plant and seed yield/plant in both seasons. Whereas, Strain 22 surpassed other studied cultivate (Sakha 2 and Giza 10) and registered the highest values of fruiting zone length, number of capsules/plant and seed yield/fed under the environmental conditions of this study in both seasons.

These findings might be attributed to the differences in their genetical constitution and their interaction with environmental conditions prevailing during growing season (Rahimi and Nourmohamadi, 2010 and Abd El-Mohsen et al., 2013)). These results are in agreement with those detected by Al-Doori (2012), Bakry et al. (2012), Wadan (2013), Gallardo et al. (2014) and Bakry et al. (2015).

2. Effect of mineral fertilization treatments:

Mineral fertilization treatments (Fertilizing with mineral nitrogen "N" only, phosphorus "P" only, potassium "K" only, combined nitrogen, phosphorus and potassium "NPK" and without mineral fertilization) showed significant effect on all studied characters *i.e.* straw yield and its components (technical length, stem diameter, straw yield/plant and straw yield/fed) as shown in Table 2, seed yield and its components (fruiting zone length, number of capsules/plant, number of seeds/capsule, number of seeds/plant, seed yield/plant and seed yield/fed) as shown in Table 3 and fiber yield and its quality (fiber length, fiber yield plant, fiber strength and fiber fineness) as shown in Table 4 in both growing seasons.

Table 4: Averages of fiber length, fiber yield plant, fiber strength and fiber fineness as affected by mineral nitrogen, phosphorus and potassium (NPK) fertilization treatments of some flax genotypes and their interaction during 2012/2013 and 2013/2014 seasons.

Characters / Treatments Seasons	Fiber length (cm)		Fiber yield plant (g)		Fiber strength (R.K.M.)		Fiber fineness (N.m.)	
	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014
A- Genotypes:								
Giza 10	69.9	61.2	0.366	0.346	35.6	36.4	325.2	335.9
Sakha 2	66.7	57.9	0.361	0.327	33.8	34.3	290.1	297.4
Strain 22	58.2	53.4	0.259	0.252	32.6	32.1	276.2	293.1
LSD at 5 %	1.5	1.9	0.018	0.014	0.7	0.7	2.3	3.1
B- Mineral fertilization treatments:								
Nitrogen (N) only	66.9	60.6	0.367	0.351	34.4	34.4	293.4	296.9
Phosphorus (P) only	64.6	56.1	0.314	0.297	33.2	33.3	286.4	289.9
Potassium (K) only	63.4	56.6	0.323	0.287	36.4	36.4	329.1	365.8
Combined NPK	71.5	65.4	0.409	0.371	35.4	35.8	320.7	322.7
Without	58.5	48.9	0.231	0.236	30.6	31.5	256.3	268.6
LSD at 5 %	1.3	2.1	0.013	0.016	0.6	0.8	2.6	4.3
C- Interaction: A×B (F. test)	NS	NS	*	*	NS	NS	*	NS

Fertilizing flax plants with mineral nitrogen (75 kg N/fed.), phosphorus (23.25 kg P_2O_5/fed.) and potassium (24.0% K_2O/fed.) significantly increased all studied characters (straw yield and its components, seed yield and its components and fiber yield and its quality) and produced the highest values of these traits as compared with other studied mineral fertilization treatments in both seasons. Fertilizing flax plants with mineral nitrogen (75 kg N/fed) only came in the second rank after application combined NPK treatment, where the differences between them were significant in both seasons. Fertilization flax plants with fertilizing with mineral phosphorus (23.25 kg P_2O_5/fed) only came in the third rank and followed by fertilizing plants with fertilizing with mineral potassium (24.0% K_2O/fed) only with respect to all studied characters in both seasons. On the other hand, control treatment (without mineral fertilization) gave the lowest values of all studied characters.

These increases in all studied characters due to using combined mineral NPK treatment may be ascribed to combine the desirable effect of nitrogen fertilizer in formation of proteins, protoplasm and chlorophyll, consequently increases cell size, leaf area, photosynthetic activity and growth characters accordingly yield attributes. Also, the function of phosphorus in building energy for metabolism of plant growth through cellular productions such as ATP and ADP from the early stages to the end of the plant's life (Marschner, 1995).In addition, the role of potassium in photosynthesis, translocation of photosynthates, protein synthesis, control of ionic balance, regulation of plant stomata and water use (Marschner, 1995 and Reddya et al., 2004), enzyme activation and osmoregulation (Mengel 2007). These results are in agreement with those obtained by Leilah et al. (2003), Dordas (2010), El-Nagdy et al. (2010), Rahimi et al. (2011), Homayouni et al. (2013), Soethe et al. (2013), Bakry et al. (2015) and Emam and Dewdar (2015).

3. Effect of the interaction:

The interaction between flax genotypes and mineral fertilization treatments showed significant effect on straw yield/plant, straw yield/fed, fruiting zone length, number of seeds/plant, seed yield/fed and fiber yield/plant in both growing seasons as well as seed yield/plant and fiber fineness in the first season, vice versa concerning other traits as presented in Tables 2, 3 and 4.

The highest values of straw yield/plant (Fig. 1), fiber yield/plant (Fig. 7) and fiber fineness (Fig. 8) were obtained from fertilizing Giza 10 cultivar with 75 kg N + 23.25 kg P_2O_5 + 24.0% K_2O/fed. This interaction treatments was followed by fertilizing Sakha 2 cultivar with 75 kg N + 23.25 kg P_2O_5 + 24.0% K_2O/fed, and then fertilizing Strain 22 genotype with 75 kg N + 23.25 kg P_2O_5 + 24.0% K_2O/fed.

Fertilizing Sakha 2 cultivar with 75 kg N + 23.25 kg P_2O_5 + 24.0% K_2O/fed produced the highest values of straw yield/fed as graphically illustrated in Fig. 2.

Fig. 1: Straw yield (g/plant) as affected by the interaction between flax genotypes and mineral nitrogen, phosphorus and potassium (NPK) fertilization treatments during 2012/2013 and 2013/2014 seasons.

Fig. 2: Straw yield (t/fed) as affected by the interaction between flax genotypes and mineral nitrogen, phosphorus and potassium (NPK) fertilization treatments during 2012/2013 and 2013/2014 seasons.

Fig. 3: Fruiting zone length (cm) as affected by the interaction between flax genotypes and mineral nitrogen, phosphorus and potassium (NPK) fertilization treatments during 2012/2013 and 2013/2014 seasons.

Fig. 4: Number of seeds/plant as affected by the interaction between flax genotypes and mineral nitrogen, phosphorus and potassium (NPK) fertilization treatments during 2012/2013 and 2013/2014 seasons.

Fig. 5: Seed yield (g/plant) as affected by the interaction between flax genotypes and mineral nitrogen, phosphorus and potassium (NPK) fertilization treatments during 2012/2013 season.

Fig. 6: Seed yield (kg/fed) as affected by the interaction between flax genotypes and mineral nitrogen, phosphorus and potassium (NPK) fertilization treatments during 2012/2013 and 2013/2014 seasons.

Fig. 7: Fiber yield plant (g) as affected by the interaction between flax genotypes and mineral nitrogen, phosphorus and potassium (NPK) fertilization treatments during 2012/2013 and 2013/2014 seasons.

Fig. 8: Fiber fineness (N.m.) as affected by the interaction between flax genotypes and mineral nitrogen, phosphorus and potassium (NPK) fertilization treatments during 2012/2013 season.

From obtained results graphically illustrated in Figs. 3, 4, 5 and 6, respectively show that the highest values of fruiting zone length, number of seeds/plant, seed yield/plant and seed yield/fed were obtained from fertilizing Strain 22 genotype with 75 kg N + 23.25 kg P_2O_5 + 24.0% K_2O/fed. The second best interaction treatments between both studied factors was fertilizing Sakha 2 cultivar with 75 kg N + 23.25 kg P_2O_5 + 24.0% K_2O/fed, and followed by fertilizing Giza 10 cultivar with 75 kg N + 23.25 kg P_2O_5 + 24.0% K_2O/fed.

CONCLUSION

From obtained results, maximum straw and seed yields and its components of flax could be achieved through fertilizing Strain 22 or Sakha 2 genotypes with 75 kg N + 23.25 kg P_2O_5 + 24.0% K_2O/fed. However, maximum fiber flax yield resulted from fertilizing Giza 10 cultivar with 75 kg N + 23.25 kg P_2O_5 + 24.0% K_2O/fed.

REFERENCES

Abd El-Mohsen, A.A. ; Amany M. Abdallah and Gamalat O. Mahmoud (2013). Optimizing and describing the influence of planting dates and seeding rates on flax cultivars under Middle Egypt region conditions. World Essays J., 1(4): 142-152.

Al-Doori, S.A.M. (2012). Influence of sowing dates on growth, yield and quality of some flax genotypes (*Linum usitatissimum* L.). College of Basic Education Res. J., 12(1): 733-746.

Ali, A. ; M. Hussain ; A. Tanveer ; M.A. Nadeem and I. Haq (2002). Effect of different levels of phosphorus on seed and oil yield of two genotypes of linseed (*Linumusitatissimum* L.). Pakistan J Agri., 39(4): 281-282.

Bakry, B.A. ; M.M. Tawfik ; B.B. Mekki and M.S. Zeidan (2012). Yield and yield components of three flax cultivars (*Linum usitatissimum* L.) in response to foliar application with zn, mn and fe under newly reclaimed sandy soil conditions. American-Eurasian J. Agric. & Environ. Sci., 12 (8): 1075-1080.

Bakry, B.A. ; O.A. Nofal ; M.S. Zeidan and M. Hozayn (2015). Potassium and zinc in relation to improve flax varieties yield and yield components as grown under sandy soil conditions. Agric. Sci., 6: 152-158.

Choubey, A.K. and K.N. Dwivedi (1995). Effect of N, P and S and their interactions on yield of and nutrient uptake by linseed (*linum Usitatissimum* L.). J. of Indian Soci. of Soil Sci. 43(1) 72 - 75.

Dordas, C.A. (2010). Variation of physiological determinants of yield in linseed in response to nitrogen fertilization. Ind. Crops Prod., 31: 455-465.

Dubey, O.P. (1994). Response of linseed to nitrogen and phosphorus. Sci., 23 (34) 37 - 38 (C.F. Field Crop Abst.,49, 1996).

El-Nagdy, G.A. ; Dalia M.A.Nassar ; Eman A. El-Kady and Gelan S.A. El-Yamanee (2010). Response of flax plant (*Linum usitatissimum* L.) to treatments with mineral and bio-fertilizers from nitrogen and phosphorus. J. of American Sci., 6(10): 207-217.

Emam, S.M. and M.D.H. Dewdar (2015). Seeding rates and phosphorus source effects on straw, seed and oil yields of flax (*Linum usitatissimum* L.) grown in newly-reclaimed soils. Int. J. Curr. Microbiol. App. Sci., 4(3): 334-343.

Gallardo, M.A. ; H. JoséMilisich ; S.R. Drago and R.J. González (2014). Effect of cultivars and planting date on yield, oil content, and fatty acid profile of flax varieties (*Linum usitatissimum* L.). International J. of Agron., Vol. 2014: 1-7.

Gomez, K.N. and A.A. Gomez (1984). Statistical procedures for agricultural research. John Wiley and Sons, New York, 2nd Ed., 68 P.

Homayouni, G. ; M. Souri and M. Zarein (2013). Effects of zinc and nitrogen on yield components of five flax genotypes. Global J. of Sci. Frontier Res. Chem., 13 (5): 1-5.

Jiao, Y. ; C.A. Grant and L.D. Bailey (2013). Growth and nutrient response of flax and durum wheat to phosphorus and zinc fertilizers. Can. J. Plant Sci., 461-470.

Khan, N.I. ; M. Akbar ; N. Lqbal and S. Rasul (2000). Bio-agronomic evaluation of linseed genotypes. Pakistan J. Bio. Sci., 3 (7): 1172-1173.

Lafond, G.P. ; B. Irvine ; A.M. Johnston ; W.E. May ; D.W. Mcandrew ; S.J. Shirtliffe and F.C. Stevenson (2008). Impact of agronomic factors on seed yield formation and quality in flax. Canadian J. Plant Sci., 88: 485-500.

Lafond, G.P. ; C.A. Grant ; A.M. Johnston ; D.W. McAndrew and W.E. May (2003). Nitrogen and phosphorus fertilizer management of no-till flax. Better Crops, 87(1): 6-11.

Leilah, A.A. ; A.T. El-Kassaby ; M.H. El-Hindi and T.A. Abu-Zaid (2003). Requirement of some flax cultivars from NPK fertilizers. Sci. J. of King Faisal Univ. (Basic and Applied Sci.), 4(2): 125-139.

Marschner, H. (1995). Mineral nutrition of higher plants. Academic press San Diego, USA.

Mengel, K. (2007). Potassium. In "Handbook of Plant Nutrition" (Eds. Barker AV, Pilbeam DJ) 1st ed. pp: 91-120.

Radwan, S.R. and A. Momtaz (1966). The technological properties of flax and methods of estimating them. El-Felaha J. (Farming) 46: 446-447 (in Arabic).

Rahimi, M.M. ; M.A. Zarei and A. Arminian (2011). Selection criteria of flax (*Linum usitatissimum* L.) for seed yield, yield components and biochemical compositions under various planting dates and nitrogen. African J. Agric. Res., 6(13): 3167-3175.

Rahimi, M.M. and G. Nourmohamadi (2010). The effect of different planting dates on yield of different medicinal flax cultivars. J. of New Agric. Sci. (Modern Sci. of Sust. Agric.), 6(19): 31-39.

Reddya, A.R. ; K.V. Chaitanya and M. Vivekanandanb (2004). Drought-induced responses of photosynthesis and antioxidant metabolism in higher plants. J. Plant Physiol., 161: 1189-1202.

Snedecor, G.W. and W.G. Cochran (1980). "Statistical Methods" 7th Ed. The Iowa State Univ. Press, Iowa, USA.

Soethe, G. ; A. Feiden ; D. Bassegio ; R.F. Santos ; S.N. Melegari de Souza and D. Secco (2013). Sources and rates of nitrogen in the cultivation of flax. African J. of Agric. Res., 8(19): 2249-2253.

Sudakov, V.D. ; T. F. Lukut; G.A Verbitskaya ; Yu. M. Tashpulatov. and G.V. Svistun (1993). Yield and quality of the output of fiber flax in a crop relation with a balanced fertilizer system in relation to the weather and the content of phosphorus and potassium in dernopodzolic sandy looms of West Byelorussia. Repor 3. The effect of fertilizer on yield and quality of the output in relation to the variety of flax and PH of the Soil. Agrokhimiya No. 4, 55 - 68. (C.F. Field Crop Abst., 47, 5949).

Wadan, A. (2013). Optimizing and describing the influence of planting dates and seeding rates on flax cultivars under Middle Egypt region conditions. J. of Sci. Res. and Rev., 1(2): 28-39.

Zimmermann, R. ; U. Bauermann and F. Morales (2006). Effects of growing site and nitrogen fertilization on biomass production and lignan content of linseed (*Linum usitatissimum* L.). J. Sci. Food Agric., 86: 415-419.

تـأثير التسميد الآزوتى ، الفوسـفاتى والبوتاسى على محصـول وجـودة الكتـان تحت ظروف الأراضى الرملية

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أجريت تجربتان حقليتان خلال الموسمين ٢٠١٢/٢٠١٣م و ٢٠١٣/٢٠١٤ م بمحطة البحوث الزراعية بالإسماعيلية – مركز البحوث الزراعية–مصر، بهدف دراسة تأثير التسميد الآزوتى ، الفوسفاتى والبوتاسى على محصول وجودة بعض التراكيب الوراثية من الكتان تحت ظروف الأراضى الرملية. أجريت التجارب في تصميم القطع المنشقة مرة واحدة فى ثلاث مكررات، حيث اشتملت القطع الرئيسية على ثلاثة تراكيب وراثية من الكتان هى؛الصنف التجارى جيزة ١٠،الصنف التجارى سخا ٢ والسلالة ٢٢. وكانت القطع الشقية لمعاملات التسميد الآزوتى ، الفوسفاتى والبوتاسى منفردة والتداخل بين التسميد الآزوتى ، الفوسفاتى والبوتاسى و بدون تسميد·

أشارت النتائج إلى وجود فروق معنوية بين التراكيب الوراثية من الكتان الثلاثة تحت الدراسة وهى؛الصنف التجارى جيزة ١٠، الصنف التجارى سخا ٢ والسلالة ٢٢ في جميع الصفات المدروسة، فيما عدا عدد البذور/ كبسولة في كلا الموسمين.

أدى تسميد نباتات الكتان بـ ٧٥ كجم نيتروجين + ٢٣.٢٥ كجم فوسفور + ٢٤ كجم بوتاسيوم/ فدان إلى زيادة معنوية في كل الصفات المدروسة حيث أعطت هذه المعاملة أعلى القيم لجميع الصفات المدروسة بالمقارنة مع غيرها من معاملات التسميد المختلفة في كلا الموسمين. بينما أعطت معاملة المقارنة (بدون تسميد) أدنى القيم لجميع الصفات المدروسة.

أظهرت النتائج انه يمكن الحصول علي أعلى القيم لمحصول القش والبذور ومكوناتهما بتسميد السلالة ٢٢ أو الصنف التجارى سخا ٢ بـ ٧٥ كجم نيتروجين + ٢٣.٢٥ كجم فوسفور + ٢٤ كجم بوتاسيوم / فدان. ,وللحصول على اعلى القيم لمحصول ألالياف بتسميد الصنف التجارى جيزة ١٠ بـ ٧٥ كجم نيتروجين + ٢٣.٢٥ كجم فوسفور + ٢٤ كجم بوتاسيوم/ فدان تحت ظروف التربة الرملية في محافظة الإسماعيلية.

Fig. 3: Fruiting zone length (cm) as affected by the interaction between flax genotypes and mineral nitrogen, phosphorus and potassium (NPK) fertilization treatments during 2012/2013 and 2013/2014 seasons.

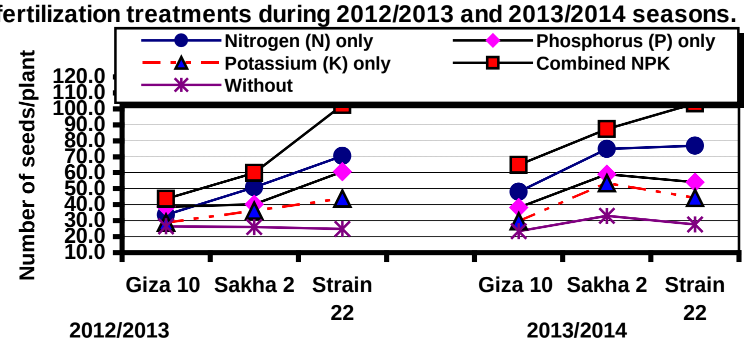

Fig. 4: Number of seeds/plant as affected by the interaction between flax genotypes and mineral nitrogen, phosphorus and potassium (NPK) fertilization treatments during 2012/2013 and 2013/2014 seasons.

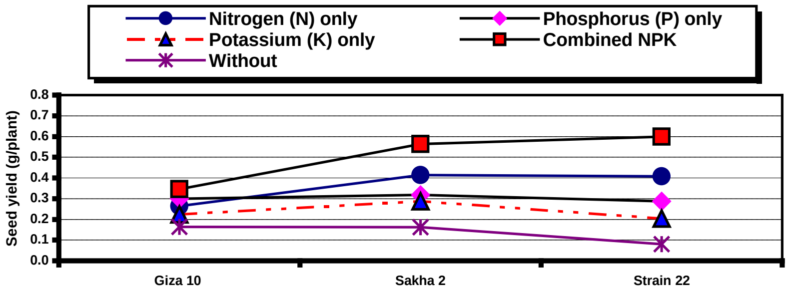

Fig. 5: Seed yield (g/plant) as affected by the interaction between flax genotypes and mineral nitrogen, phosphorus and potassium (NPK) fertilization treatments during 2012/2013 season.

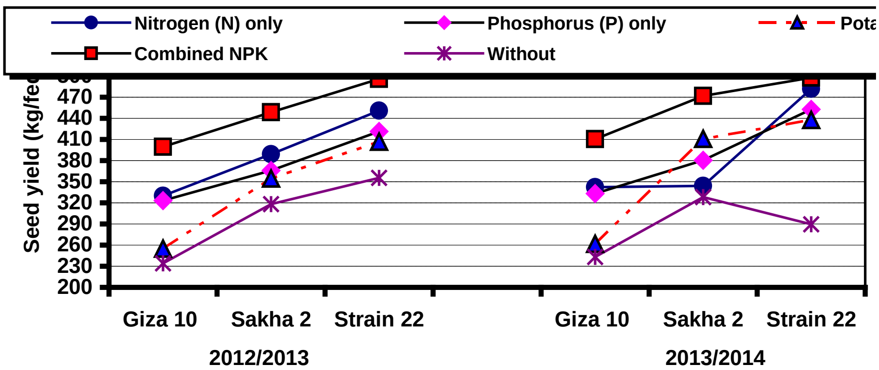

Fig. 6: Seed yield (kg/fed) as affected by the interaction between flax genotypes and mineral nitrogen, phosphorus and potassium (NPK) fertilization treatments during 2012/2013 and 2013/2014 seasons.

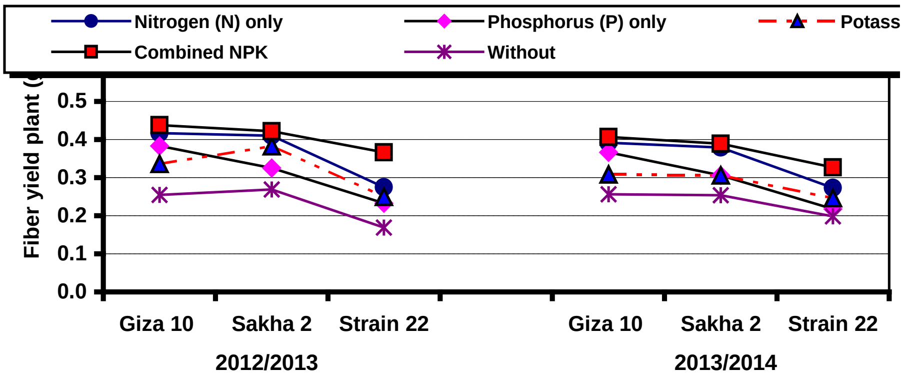

Fig. 7: Fiber yield plant (g) as affected by the interaction between flax genotypes and mineral nitrogen, phosphorus and potassium (NPK) fertilization treatments during 2012/2013 and 2013/2014 seasons.

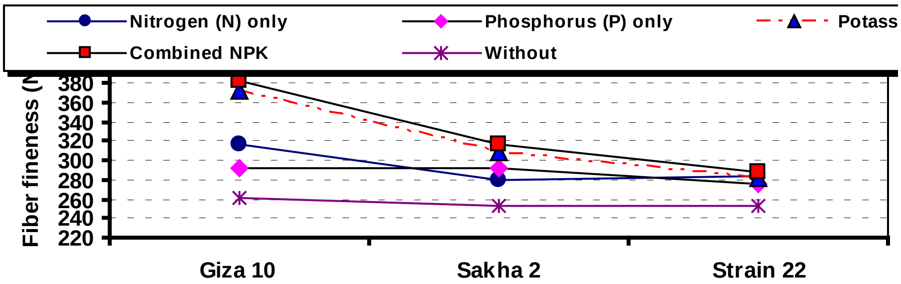

Fig. 8: Fiber fineness (N.m.) as affected by the interaction between flax genotypes and mineral nitrogen, phosphorus and potassium (NPK) fertilization treatments during 2012/2013 season.